MINISTRY OF PUBLIC WORKS, EGYPT.

Department of Agriculture.

WHEAT RUST.

EGYPTIAN AGRICULTURAL NOTES

EDITED BY

THE DIRECTOR-GENERAL OF THE DEPARTMENT OF AGRICULTURE,

ASSISTED BY

THE ADVISORY STAFF OF THE DEPARTMENT.

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DEPARTMENT OF AGRICULTURE.

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WHEAT RUST.

The appearance of "Rust," locally called "Hamra," in a severe form, upon wheat in Balliana (Girga), was reported by Ibrahim Effendi Fahmi, Inspector of the district; and the special information in this note upon the subject has been furnished by Mr. Lawrence Balls, the Botanist to the Department.

The Inspector observed that although the attack was very severe and appeared almost general in some fields, a few plants, although surrounded by diseased ones, were unaffected. The importance to be attached to this circumstance will be seen in the following account.

The name "Rust" is applied to several different kinds of parasitic fungi attacking wheat and barley, but only one kind has as yet appeared commonly in Egypt upon the wheat crop. This, however, is of such common occurrence that it may be found in every wheat field in early summer. In most cases the attack is so slight that the crop is inconspicuously affected, but it may become so severe that it is ruined.

The nature of fungi.—Fungi belong to a low order of plants, which possess no green colouring matter, and which are consequently obliged to obtain nourishment from organic substances. The food of most fungi is derived from dead substances, but some affect living plants and often become dangerous enemies to the cultivator.

An example of a fungoid attack.—Perhaps the best known example of a fungus is that which may be seen appearing on human food such as bread, which has been left in a favourable place far development for several days. In a damp position this fungus known as

"mould" appears externally as a velvety coating; the internal part, consisting of fine branching tubes radiating in the food substance can not be seen without the aid of a sufficiently powerful magnifying glass. This internal system in some respects corresponds to the root seen in an ordinary plant.

The external filaments of the commonest mould found in Egypt are white in the first instance, but become black, green or pink, indicating the appearance of bodies known as spores at their extremities. There is a great number of different kinds of fungi, and, even among the moulds which appear upon food stuffs, the forms found are as distinct from one another as corn is from cotton.

Reproduction.—The ripe spores, appearing upon the extremities of the filaments of the mould fungus referred to, are easily distributed by any disturbance of the air, and should one happen to alight upon a situable food supply, such as a moist piece of bread, it commences to absorb the moisture and swells up, producing a new filament. This filament decomposes the bread and feeds upon the product, increasing in the interior of the bread until it is sufficiently developed to produce more external filaments and a fresh crop of spores. This example is sufficient to show the general development of a fungus.

Parasitic fungi.—The description given above for the mould fungus is broadly applicable to the fungus which is being specially referred to here, and which feeds upon the living tissues of the wheat. The rusty yellow postules, which appear upon the plant, represent the crop of spores, indicating that a fine network of filaments exists beneath them and has developed within the plant tissues to such an extent as to produce the spores externally. These rusty spores are spread from one plant to another in the same manner as the mould spores mentioned above.

Parasitic fungi are frequently not possessed of the power of attacking plants unless in an unhealthy condition. Some are capable of attacking healthy plants of all kinds, others, only allied kinds, and some, only particular races. Mr. Balls remarks that the rust of wheat is one of the most specialized of all parasitic fungi, and, in spite of the apparent similarity of the rust pustules on wheat to those on

barley, the spores from the one are unable to infect the plant producing the other.

Infection by spores. — The pustules appearing upon the leaves, stem, or even the ears of wheat, in Egypt, consist mainly of spores, each of which is spherical and yellow. The spores are so light that they are easily dispersed to considerable distances by wind or other means. If a spore falls upon the surface of a wheatle af on which there is a small amount of moisture, such as dew, a fine filament is produced which, entering a breathing aperture, spreads within a minute patch of tissue and reproduces fresh spore pustules. The actual damage to the plant is due to the patches of injured or weakened tissue which are thus formed.

Black Rust. — Later in the season, the pustules assume a nearly black appearance, which is not due to the existence of a different kind of fungus, but to the production of a different kind of spore from the same filaments. These spores are dark brown in colour and have thicker walls.

The prevention of Wheat Rust. — The chemical sprays usually employed for checking and destroying fungoid pests cannot be successfully applied to the rust fungi.

The recognized method for the prevention of wheat rust is by the selection of immune kinds. It has been found that, if several kinds of wheat are sown in the same field, where the liability to infection is equal for them all, some may be so badly attacked that they will not set any seed, while others may not develop a single pustule, even though their leaves may be in contact with the infected kinds. The causes of this immunity or susceptibility are as yet incompletely comprehended. The advantage obtained from the knowledge or their existence is, however, clear.

It should be born in mind that a strain which is found to be immune from the attacks of one kind of wheat rust, is not necessarily so from another, but, as observed before, there is apparently only one kind of wheat rust at present known in Egypt, and the establishment of a resistant strain is therefore facilitated.

It may be mentioned that the characters—immunity and susceptibility—are inherited. It is therefore possible for the expert plant breeder, by crossing immune wheats which are otherwise undesirable with desirable kinds, to breed immune forms with desirable characters.

The point, that in order to ensure the same results with regard to hereditary transmission of immunity, the same weather conditions are necessary, must not be lost sight of. Mr. Balls remarks that in Giza District, no rust pustules are apparent until about the middle of March. These increase until they may be very prevalent when the crop is maturing, although too late to do much harm. When this wheat is sown late, the attack may be so severe that the crop is seriously affected.

A microscopic examination of wheat in the winter at Giza will frequently reveal the fact that the spores of the fungus have been attacking the plant but have not succedeed in infecting it. This has led to the conclusion that it is immune in the cold weather but becomes susceptible when the hot weather commences. The rust appearing upon beans is similarly influenced, early-sown beans often escaping infection when late are attacked. If this is merely an effect of the temperature it may reasonably be assumed to account for the prevalence of wheat rust in Upper compared with Lower Egypt. A variety of wheat which shall retain immunity throughout the winter and until the time of harvest is desirable, or if not procurable, one which will remain unaffected as late as possible should be obtained.

The selection of Rust-proof Wheat. — There is usually a number of different kinds of wheat found in an ordinary wheat field; moreover there may be two kinds exactly resembling one another, one of which, may be immune and the other susceptible. The seed should be selected from the kinds which do not exhibit infection, and from this the propagation of the crop for future sowings should be made. The selection of plants from which to take the immune seed should be made late in the season, as during the winter all Egyptian wheats are usually free from apparent attacks. Again, the immune plants should be chosen from those parts of a field which are the most affected, in order that the apparent immunity may not be attributable to advantage of position or other accidental cause. Just previous to the ripening of the wheat,

the immune forms in an affected field will be seen to stand out prominently green among their rusty companions, but, as Mr. Balls suggests, it is a good plan to make a preliminary search some 3 weeks before this time, and a number of apparently immune plants should be marked by attaching a strip of blue cloth to each of their stems.

Any which are subsequently attacked by the disease should be reaped in the ordinary way, only those which continue unaffected being left standing by the reapers. If sticks be used instead of strips of cloth, care should be taken to tie to each stick one plant only.

Each plant's seed should be collected separately and given a number for identification, and should be sown in the following season in rows or plots near wheat likely to suffer from rust. Comparison of these rows will show which families are superior in their power of rust resistance. Care should also be taken to observe the other qualities exhibited by the different rows, and particular attention should be paid to early maturity, as the early kinds are less susceptible to attack than the late.

Operations in planting the seed from selected kinds and their descendants should continue until a sufficient quantity of seed has been obtained to provide for the sowing of the complete field area. Elimination of undesirable kinds should proceed during the whole period of the experiment. Mr. Balls advises that the strains derived from each original plant should in no case be mixed, regardless of their apparent similarity, unless upon the advice of an expert.

That the produce of a single plant is quickly able to reproduce a quantity sufficient to sow a large area is exemplified by an experiment conducted by Mr. Balls for the Khedivial Agricultural Society. The main points in this experiment, as far as they concern the present subject, are that from the descendants of two seeds which were sown under field conditions in 1906, an area of forty feddans was sown in 1909, which yielded as a seed crop for sowing in 1910 about two hundred and seventy ardebs. The estimated crop for sowing in 1911 is about two thousand ardebs from each of the original two plants selected in the spring of 1907. Mr. Balls further remarks that had more care been taken in the first instance to obtain as many seeds as possi-

ble from the original seed, by sowing under garden conditions, the quantity mentioned above might have been trebled.

A summary of the contents of this circular is a follows :—

A. Wheat rust is due to a special parasitic fungus.

B. Infection is carried by the wind, etc., distributing the light spores.

C. The only method of preventing rust is by selecting and planting seed from immune varieties.

D. Immune plants, carrying immunity as a hereditary character, occur among the susceptible plants in the fields and are easily distinguishable.

E. A single seed is capable of multiplication to five thousand ardebs in five years, i.e., a single plant will produce this amount in four years.

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DEPARTMENT OF AGRICULTURE.

EGYPTIAN AGRICULTURAL NOTES.

WHEAT SMUT.

In the Agricultural Notes, 1911, No. 1, a description is supplied with regard to the general habits of fungi, with special application to the action of that known as "Wheat Rust." In the following account of "Wheat Smut," called "El Hamira," reference should be made to the publication quoted above as the various diseases known as "Smut" found upon wheat, barley, maize and other cereals are due to allied parasitic fungi.

The occurrence of the disease upon wheat has been reported from Upper and Lower Egypt, and in some localities the extent of the attack has been severe. Information in respect to the life history is given here, as well as the methods recommended for treatment of the disease.

Appearance of Infected Wheat.—The wheat plant, although infected early during its life, does not exhibit external signs of the fungus until the ear is formed. In infected plants the seed then appears as a mass of black powder, resembling soot, which consists of the minute spores of the fungus which has developed and destroyed the ovaries.

Mode of Infection.—The dissemination of the spores is effected by wind and mixture of infected and healthy seed. The spores are capable of germinating in water, and reproducing other spores which can infect other wheat plants. Unlike the spores of "Wheat Rust" the plant cannot become infected except at the tender growing tissues of the seedling plants and by a means to be mentioned later. In order

to procure a susceptible host plant, the spores may undergo a period of suspension from one season to another either in the soil or mixed with healthy grain. If infection can be prevented when the seed is germinating, the plants raised from such seed will be safe for the remainder of their lives and will not develop smutted ears.

Prevention of Infection.— The method indicated for use to combat the disease must afford protection to the germinating seed from infection from spores in the soil as well as from those mixed with the healthy grain. This can be accomplished by dressing the seed with various poisonous substances ; and that which is recommended for adoption in Egypt, where the weather is too warm to admit of a lengthened period of soaking, is a ten per cent. solution of copper sulphate. The price of copper sulphate ($CuSO_4$) in Cairo is from 35 to 70 milliemes per kilo. The solution can be poured over a heap of the seed just previous to sowing, and the whole heap stirred up in order to allow every seed to be thoroughly wetted by the poison. After this the seed can either be spread out to dry, or wood ashes can be sprinkled with the mass to assist in absorbing the moisture. After the seed has been sown, the hands of the sowers should be washed, as, although the copper sulphate is harmless externally, internally it is not so.

Persistence of Disease.—In spite of what has already been said with regard to infection, it should be mentioned that recent investigations have resulted in the discovery that even when wheat has been disinfected from the external influence of the disease in the manner indicated, some of the plants continue to develop smutted grains. This is not necessarily due to inefficiency of the disinfectant, but to another method of infection. When the wheat is in flower the spores of the disease may alight upon the feathery stigma, and may grow down into the ripening seed. No distinction can be made by the naked eye between seed thus infected and healthy seed, nor is it possible to effect a cure in this case, as the external applications of poisonous solutions cannot affect the disease, which is safely protected by the tissues.

No data are at present available to shew to what extent the "Smut" on wheat in Egypt is dependent upon the two methods of

infection mentioned; but in any case, the dressing of seed, as recommended, will at least largely reduce the number of smutted ears, and so prevent the spread, to healthy ears, of infection by the second method.

It may be mentioned that in most European countries the treatment of seed to a dressing in the above manner is an ordinary operation in agricultural practice.

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